

## REMARKS/ARGUMENTS

Claims 1-4, 6, 8-15 and 16-18 are pending in this application. Claims 12-15 are withdrawn from further consideration by the Examiner.

In this response, claim 1 is amended to more clearly recite applicants' process. The amendments to the subject claim are supported by the application as filed and there is, thus, no issue of new matter. In particular, support for the recitation of the "separation step" is found, *inter alia*, on p. 3, lines 18-20, p. 8, lines 6-12 and 14-16, p. 14, lines 11-14, p. 15, lines 18-20 and p. 19, lines 13-19 and 21-23. Support for the paragraph detailing the arrangement of the feed compacts in the reaction device is found, *inter alia*, on p. 6, lines 4-22, p. 9 line 19- p. 10 line 6, p. 13, lines 1-7 and 15-20, p. 17, lines 10-25 and Fig. #1. Support for the paragraph directed to maintaining the shape of the metal compound feed compacts is found, *inter alia*, at p. 8, lines 12-14, p. 14, lines 7-9 and 19-21 and p. 19, lines 19-21.

Additionally, claim 4 has been amended to place the claim in better form. Further, claim 9 is amended to further limit the temperature of the metal compound feed compact in the reducing step, while claim 10 has been amended to recite that the distance from an arbitrary location within the metal compound feed compact to the surface of the compact following the molding step is 2 to 5 mm. Still further, claim 17 is amended to recite that cations in the reaction agent are blended at 0.5 to 1 mole with respect to 1 mole of the metal contained in the metal compound feed compact. Furthermore, two new claims, i.e., nos. 19 and 20, are proposed for addition to the application. Support for these additional claim amendments may be found, for example, at p. 10, lines 13-14 for claim 9; p. 12, lines 9-10 for claim 10; p. 12, lines 1-3 and p. 18, line 20 in the case of claim 17. Support for the new claims is present at, for example, p. 11, line 2 (new claim 19) and p. 13, lines 9-12 (new claim 20). Thus the amendments to claims 4, 9-10 and 17 and the addition of new claims 19-20 also are entirely supported by the application as filed and do not add any new matter into this application.

Entry of the proposed claim amendments and new claims is, therefore, respectfully solicited. Upon such entry, therefore, claims 1-4, 6, 8-11, 16-18 and 19-20 will be presented for examination, whereas claims 12-15 remain withdrawn from consideration.

### **Statement of Substance Regarding August 20, 2008 Interview**

Applicant appreciates the courtesy extended to his representative, Mark A. Farley, Esq. during a telephonic discussion regarding this application on August 20, 2008 with Examiner Weiping Zhu.

On August 11, 2008 applicant's representative faxed a proposed amended claim 1 to the Examiner which was to be discussed during the interview scheduled for August 20<sup>th</sup>. During the telephone discussion of this application on August 20<sup>th</sup>, applicant's representative informed the Examiner that in applicant's view the proposed amended claim distinguishes the process recited therein from the prior art cited by the Examiner to reject the claims of the application. In response, as noted in the Examiner's Interview Summary mailed August 25, 2008, the Examiner reminded applicant's representative that all claim amendments must be supported by the instant specification (the Examiner did not allege, however, that the amendments were not supported). The Examiner then stated that the prior art references would be further reviewed to determine if they recited the features added by amendment and that, if they did not, the Examiner would conduct a further search of the art. There was no specific discussion, however, of the features added by amendment to proposed claim 1.

### **Claim Rejections Under 35 U.S.C. §103**

Claims 1-3, 6, 8-11 and 16-18 are rejected under 35 U.S.C. §103 as being allegedly unpatentable over U.S. Patent No. 6,136,062 to Löffelholz, *et al.* in view of U.S. Patent No. 5,417,917 of Takahar, *et al.* and further in view of U.S. Patent No. 6,015,527 of Kamei, *et al.* The bases in support of these rejections are set forth on pp. 2-5 of the Office Action. The rejections are respectfully traversed in light of the amendments to the claims, taken in conjunction with the remarks below.

Claim 1 is the only claim under examination that is written in independent form. The process recited therein is a metal powder production process using a metal compound powder as a raw material, wherein the metal compound powder is thereafter reduced. The process comprises the following steps:

- a molding step in which the metal compound powder is mixed with a binder and a reaction agent, wherein the mixture is molded and sintered to produce a metal compound feed compact;

- a reducing step in which a metal is formed by reducing the metal compound feed compact by contacting the metal compound feed compact with an active metal as a reducing agent; and

- a separation step in which the metal formed in the reducing step is separated from a surplus of the active metal, by-products and a surplus of the reaction agent included in the metal compound feed compact.

Furthermore, and as also recited by (amended) claim 1:

- in the reducing step the active metal is arranged at a distance from the metal compound feed compact and vaporized by heating so that the vaporized active metal is supplied to the metal compound feed compact;

- in the reducing step, a plurality of metal compound feed compacts are arranged in a sealed reaction device in such a manner as to diffuse the vaporized active metal among the metal compound feed compacts so that the plurality of metal compound feed compacts simultaneously come into contact with the vaporized active metal, and do not contact the inner wall of the reaction device by being supported with a supporting device; and

- the shape of the metal compound feed compacts before and after the reducing step is substantially the same.

wherein

- the reaction agent is at least one compound of an active metal selected from calcium, magnesium, sodium, barium and potassium.

Applicant submits, therefore, that as discussed further below, successively conducting (a) the molding step, (b) the reducing step, and (c) the separating step having the features as recited above (i.e., as in claim 1), permits - in contrast to the processes described in the prior art cited to reject the claims - production of a highly pure metal powder to occur on a large scale.

A brief discussion of the unexpected advantages (i.e., over the 'prior art') attributable to the various technical features of the claimed process (including features added herein by amendment to claim 1), is believed to be in order to assist in understanding how the invention, as now claimed, is distinguishable over the cited prior art. The advantages provided by the claimed method serve to support applicants' contention that the process recited in (amended) claim 1 is not obvious over the combination of references relied upon to reject the claims.

For example, claim 1 recites that in the molding step the metal compound powder is mixed with, *inter alia*, a reaction agent. The reaction agent is defined by the subject claim as being at least

one compound of an active metal selected from calcium, magnesium, sodium, barium and potassium. While the active metal compound used as a reaction agent can serve as a binder, it is also used in the presently claimed process to control the morphology of the metal (e.g., niobium) powder thus produced, as well as for increasing the efficiency of the acid treatment used in the separation step. Furthermore, adding the reaction agent to the metal compound and the binder in the molding step permits the reaction agent to function more uniformly in the reducing step and also results in an increase in production efficiency of the resultant metal powder product when the metal compound starting material is reduced. Moreover, the particle size of the resulting metal powder is controlled in applicants' process by regulating the type and ratio of the reaction agent. The presence of the material additionally assists in preventing contamination of the final powder product due to contact with the reaction vessel, i.e., in the molding/reducing step.

The references cited in the Office Action, however, do not display an appreciation of the important role (as described above) played by the reaction agent in the method as recited in applicants' claim 1.

Furthermore, the reaction efficiency and uniformity of the reducing step are enhanced by the use of a metal compound feed compact (i.e., as produced in the molding step) which, as recited in claim 1, contains the reaction agent. Still further, by sintering the raw material to form a feed compact the amount of reducing agent used can be reduced and carbon contamination of the resultant powder product is also prevented. In addition, as also recited in claim 1 the reducing step is carried out upon a metal compound feed compact, the shape of which remains substantially the same both before and after the feed compact undergoes reduction. Consequently, during the performance of the (acid) separation step carried out upon the metal compound feed compact following the reducing step, the efficiency of removing the by-products and the reducing agent from the compact is substantially increased. These advantages are nowhere discussed or described in the prior art cited to reject applicants' claims.

As to the arrangement of the plurality of metal compound feed compacts, i.e., as now recited in (amended) claim 1, applicants submit that arranging the feed compacts in a reduction device such that a diffusion path through the gas phase is maintained permits a more uniform diffusion of the vaporized active metal. Thus the feed compacts and the active metal are more uniformly contacted which, accordingly, permits the reduction reaction to proceed more uniformly in terms of both time and space while, at the same time, also increasing the efficiency of the reduction reaction.

Furthermore, since the feed compacts do not have any direct contact with the reduction device, contamination due to such contact is prevented - thereby increasing the purity of the resulting metal powder.

These additional advantageous aspects of the presently claimed invention are also not recognized by the references relied upon by the Examiner to reject applicants' claims and, thus, they provide additional evidence as to the non-obviousness of the claimed process.

Still further, the recitation (in claim 1) that the compacts having the reduced product (i.e., the formed metal powder) have substantially the same shape as the metal compacts prior to the reducing step is another important aspect of applicants' claimed process. It means that permeability (i.e., into the feed compact) of an acid reagent applied in a subsequent separation step is satisfactory, thus enabling the final powder product to be separated from the feed compact rapidly and uniformly. Additionally, the handling characteristics of the claimed feed compacts after the reduction step, i.e., having substantially the same shape as before the reduction step, are excellent.

Further to the above the separation step now recited in (amended) claim 1 permits ready separation of the metal formed in the reducing step from the surplus of reducing agent and reaction agents, and the by-products generated during the reduction reaction, thereby permitting the production of a highly pure metal powder on a large scale.

In summary, the discussion above focuses on the advantages offered with the use of the presently claimed (see, e.g., amended claim 1) process that are unrecognized by the authors of the references cited in this case to reject applicants' claims. Since the features which provide these advantages are recited in the amended language of claim 1, both claim 1 and those claims depending therefrom are believed to be non-obvious over the disclosure of the cited art such that the rejection based on §103 should be withdrawn.

We now turn to a more specific discussion of the features described in the particular references relied upon by the Examiner to reject applicants' claims. In this regard, applicants submit that Löffelholz, *et al.*, as noted in a prior response, states that in the reduction of heavy metal oxides by alkaline earth metals or hydrides the control of the reduction reaction is difficult. Thus, the patentees developed a two-stage reduction process in an effort to overcome the difficulties identified in the reference. The process described by the reference, however, is neither the same as, nor does it suggest, the presently claimed process as recited, e.g., in (amended) claim 1.

In contrast to the disclosure contained in Löffelholz, *et al.*, the Takahar, *et al.* reference does not disclose the reduction of heavy metal oxides, e.g., niobium and tantalum, and also does not disclose a production process, i.e., such as that which is presently claimed by applicants, for producing a metal powder.

In light of the factors discussed above, therefore, applicants submit that there is no way that even the combination of Löffelholz, *et al.* and Takahar, *et al.* would be deemed to teach or even suggest the process as presently recited in applicants' claims.

Turning next to the Kamei, *et al.* reference combined by the Examiner with Löffelholz, *et al.* and Takahar, *et al.*, applicants submit that the subject reference also does not disclose the reduction of heavy metal oxides, or that a reaction agent (as noted above) may be used not only to promote the reduction reaction, but also to control the particle size of a resultant heavy metal powdered product, as is the case in the process claimed by applicants. Further, as indicated in col. 5 at line 23, Kamei, *et al.* teaches to use, "powdery solid reductants" which, as previously argued by applicants, are not the same as, nor equivalent to, the agents recited for the indicated purpose in the claims of the present application. Further to the above, at column 8, lines 7-10, Kamei, *et al.* further define the 'powdery solid reductants' as referring to powders of a mainly solid material containing mainly carbon, which is, of course, a different material than that recited for use in the presently claimed process.

Still further, Kamei, *et al.* teaches that the reaction described therein takes place within a "sheet-like compact" defined as, "a continuous band formed by compacting a mixture of fine iron oxides and powdery solid reductants" (col. 8, lines 11-14). Thus, the compact produced according to the reference is of a different form than that taught for use in the presently claimed process.

As may be discerned from the discussion above, even when the cited Löffelholz, *et al.*, Takahar, *et al.* and Kamei, *et al.* references are taken in combination, they still do not teach or suggest the process as presently recited in applicants' (amended) claim 1. Furthermore, since the remaining rejected claims all depend directly or indirectly from claim 1, and thus they contain all of the recitations set forth in the independent claim, the dependent claims are also believed to be distinguishable over the cited references for the same reasons as claim 1.

Still further to the above, the following is provided in response to several of the remarks/arguments set forth by the Examiner in the present Office Action.

The Examiner admits in the Office Action (see p. 4, in the paragraph beginning on line 4), that the combination of Löffelholz, *et al.*, Takahar, *et al.* and Kamei, *et al.* does not specify the claimed features (i.e., of claim 1 prior to its amendment herein) of the reducing step, but then he argues that it would have been obvious to use a compound (e.g., an oxide) of an active metal selected from calcium and magnesium (Löffelholz, *et al.*, col. 1, lines 62-65) as the reaction agent, as disclosed by Kamei, *et al.* (col. 8, lines 29-34 and 62-65). Applicants take this to mean that the Examiner believes that the reducing agent of the Löffelholz, *et al.* reference can be replaced by calcium oxide or magnesium oxide. Applicants note in response, however, that, for example, a glass substrate ( $\text{SiO}_2$ ) can not be readily replaced with a wafer of Si in, e.g., the production of a computer chip, nor can window glass ( $\text{SiO}_2$ ) be replaced with Si. Applicants' position, therefore, is that since there is no basis, other than the unsupported opinion of the Examiner, for the proposition that the substitution referred to in the Office Action could be effectively made, the argument presented in the Office Action should not be accorded any substantial weight.

Further, since the powdery reductant of Kamei, *et al.*, which corresponds to the reaction agent used in the present invention, is a reducing agent, the Examiner appears to believe that the reaction agent of the present invention works as a reducing agent. Applicants submit, however, that as would be well known in the relevant art, if  $\text{CaCl}_2$ ,  $\text{CaO}$  or  $\text{NaCl}$ , which do not have a reduction ability, were to be mixed with, for example, niobium oxide or tantalum oxide and then heated, a reduction reaction would not occur. Thus, the replacement of one compound by the other, as suggested by the Examiner, would be technically inconsistent. Based on the above, therefore, the indicated replacement would not be obvious to one having an ordinary level of skill in this field.

Applicants additionally respectfully disagree with the statement contained in the paragraph bridging pp. 3-4 of the Office Action, i.e., that it would have been obvious to one of ordinary skill to mix a metal compound, a reaction agent and a binder together for molding, as disclosed by Kamei, *et al.* in the process of Löffelholz, *et al.* in view of Takahar, *et al.* Based on their knowledge as ones having at least an ordinary level of skill in the relevant field, applicants submit that if the technique disclosed in Kamei, *et al.*, in which a preliminary reduction is achieved by the addition of a reducing agent to a feed compact, were to be applied to the process disclosed in Takahar, *et al.*, a problem may occur during the reduction of, for instance, niobium or tantalum oxide. That is, because the Löffelholz, *et al.* and Kamei, *et al.* references do not disclose any compounds mixed with a raw material other than the reducing agent, the resultant method obtained by combining the references

as suggested by the Examiner would be a method in which a feed compact is produced by mixing a raw material a reducing agent (i.e., Mg, Ca according to Löffelholz, *et al.*) and a binder.

However, it would be understood by one working in this field that a feed compact obtained by combining the methods of Löffelholz, *et al.* and Kamei, *et al.* would be reduced by the reducing agent included in the feed compact at the sintering step, during which a heat treatment is performed to remove the binder. It is apparent to applicants, therefore, that the reduction reaction could not be controlled in the manner alleged by the Examiner and also that a metal powder having the desired size (diameter) could not be obtained thereby.

Put another way, even the combination of Löffelholz, *et al.* and Kamei, *et al.* would not be effective in solving the problems described in the Löffelholz, *et al.* reference and, therefore, there would be no motivation to combine Löffelholz, *et al.* and Kamei, *et al.* Furthermore, none of the other references cited in the prosecution of this application disclose or even suggest techniques useful in solving this difficulty.

In contrast to the teaching(s) supplied by the combination of references applied by the Examiner, in the presently claimed process a feed compact is molded by mixing a reaction agent (e.g., CaCl<sub>2</sub>, MgCl<sub>2</sub>) which does not work as a reducing agent by itself, and a binder, thereby preventing the problems which would otherwise occur when the reduction reaction occurs during the step of molding the feed compact.

With regard to the Examiner's comments relating to the patent to Takahar, *et al.*, applicants note that the Löffelholz, *et al.*/Kamei, *et al.* references disclose a solid/liquid reducing agent, while Takahar, *et al.* teaches to use a gaseous reductant agents. Thus, Takahar, *et al.* provides an alternate to the reducing agents disclosed in Löffelholz, *et al.* and Kamei, *et al.* One having an ordinary level of skill in this art would thus be faced with selecting one particular method for supplying a reducing agent (i.e., choosing what form the agent would take - solid, liquid or gas), since to supply the reducing agent in more than one form (e.g., a solid and a gas) during the process of forming the powdered metal final product would not be a step taken by one having ordinary skill in this art. Thus, the method obtained by combining the references along the lines suggested by the Examiner would be one of the following:

- (a) supplying a gaseous reducing agent to a feed compact including only niobium/tantalum oxide;
- or
- (b) heating a feed compact including niobium/tantalum oxide and a liquid/solid reducing agent.

Method (a) above does not satisfy the presently claimed feature of applicants' process wherein the feed compact includes a reaction agent. Furthermore, method (b) does not satisfy another claimed feature of applicants' process, i.e., wherein the reducing agent is supplied in a vaporized form. This demonstrates, therefore, that even the combination of the subject references would not lead to applicants' process as presently claimed.

Applicants respectfully submit that claim 1 (as amended) is thus believed to be distinguishable over the cited combination of references, in view of the amendments made to claim 1 taken in conjunction with the arguments presented herein.

As indicated herein, applicant has additionally amended certain of the dependent claims, i.e., depending from claim 1, to further clarify the features of the presently claimed process. For instance, claim 9 as amended now recites that the temperature of the metal compound feed compact in the reducing step is 800 to 1000 °C. Applicant submits that at temperatures below the low end of the range the vapor pressure of the active metal used as the reducing agent tends to be lowered and thus the reducing reaction does not proceed as adequately as is desirable. Alternatively, at temperatures above the upper end of the range, sintering of the metal powder formed by the process, which is obviously an undesirable result, tends to occur. Applicant submits that the claimed aspect is not recognized by the cited references which teach that the reason for maintaining a certain temperature range in the reducing step is to prevent excessive reduction. This, then, provided additional evidence of the unobviousness of claim 9.

Claim 10 is amended herein to recite that the metal compound feed compact is molded into a shape in which the distance from an arbitrary location within the compact to the surface of the compact is 2 to 5 mm. As a direct result of having the claimed shape, the reduction reaction may be carried out more uniformly.

Additionally, claim 17 has been amended to recite that the cations in the reaction agent are blended at 0.5 to 1 mole with respect to 1 mole of the metal contained in the metal compound feed compact. Above the claimed range, the amount of acid used for the acid washing step tends to increase, while leaching efficiency tends to decrease, when separating the final metal product via an acid treatment.

The claim amendments discussed above are, thus provided to further distinguish applicant's process from the prior art cited in the present Office Action concerning this application.

The Examiner is, therefore, respectfully requested to reconsider and withdraw the rejection of claims 1-3, 6, 8-11 and 16-18.

Further to the above, on p. 6 of the Office Action claim 4 is rejected under 35 U.S.C. §103 over Löffelholz, *et al.* in view of Takahar, *et al.* and further in view of Kamei, *et al.* as applied to claim 1, and further in view of U.S.P. 3,839,020 to Honma, *et al.* The rejection is respectfully traversed.

Claim 4 is dependent upon claim 1. Thus claim 4 includes all of the recitations contained in (amended) claim 1. For the reasons set forth above, claim 1 is believed to be distinguishable over the combination of Löffelholz, *et al.* in view of Takahar, *et al.* and further in view of Kamei, *et al.*

As to the remaining reference, i.e., the patent to Honma, *et al.*, according to the Office Action it is added to the combination by the Examiner due to its disclosure relating to the reduction of zirconium compounds by contacting them with an active metal. Applicants respectfully submit, however, that a close reading of the subject reference demonstrates that it does not supply the presently claimed elements of applicant's process that are missing from the combination of Löffelholz, *et al.* in view of Takahar, *et al.* and further in view of Kamei, *et al.* Applicants therefore believe that claim 4 is also distinguishable over the combination of references cited to reject it. The Examiner is, thus, respectfully requested to reconsider and also withdraw the rejection of claim 4 under 35 U.S.C. §103.

As indicated above, new claims 19 and 20 are added herein to the application. Both of these claims depend directly upon claim 1. As such, the subject claims contain all of the features recited in claim 1 and they are believed to distinguish over the prior art for the same reasons as claim 1.

With regard to new claim 19, applicant submits that the present specification teaches that the mixing ratio of the, e.g., niobium, raw material in the niobium feed compacts is preferably not less than 10% by weight. Applicant respectfully submits that the cited combination of references does not teach or suggest the aspect of the invention presently recited in new claim 19, which should thus be allowed.

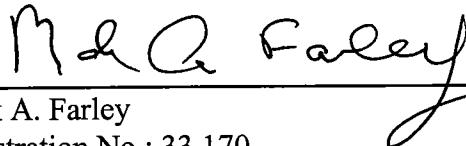
New claim 20 recites that the content of the active metal is at 50 to 400 parts by weight with respect to 100 parts by weight of the metal compound feed compact. As taught, e.g., at p. 13 of applicant's specification, when the active metal is included at less than 50 parts by weight, "the reduction reaction tends to not proceed adequately" (p. 13, line 11). Furthermore, when this material is included at more than 400 parts by weight, "the reduction efficiency tends not to improve" (p. 13,

line 12). As in the case of claim 19 discussed above, the feature recited in claim 20 is not taught believed to be recognized by the teachings contained in the cited prior art.

The Examiner is, thus, respectfully requested to additionally allow new claims 19 and 20.

Respectfully submitted,

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